ERIC Document Resume	See Instruction Sheet	DATE OF RESUME 8/2/65	DATE RECEIVED

A. PUBLICATION DATA

1. ERIC NUMBER	2. ORIGINATOR CONTROL NO(S).	3. IDENTIFICATION NO.
ED 010273	7115	N.A.

DO NOT WRITE IN SPACE BELOW

4. AUTHOR(S):

N.A.

MICROFILM COPY AVAILABLE YES ☒ NO ☐

5. TITLE OF DOCUMENT ABSTRACTED:

Progress Report: Improved Teaching Materials, Equipment, and Facilities

COPYRIGHT GRANTED YES ☐ NO ☒

COPYRIGHT RELEASE FILED YES ☐ NO ☐

6. PUBLICATION TITLE:

Toward More Effective Teaching at Rensselaer, No. 7

TYPE OF REPORT
PROPOSAL ☐
IN-PROGRESS ☐
FINAL ☒
FOLLOW-UP ☐

7. EDITOR(S):

N.A.

8. PLACE OF ORIGIN
ORG. RPI
ST. Troy, New York
CITY, STATE
TELE. EXT
INST/LOC CODE

9. PUBLISHER OR SOURCE

Rensselaer Polytechnic Institute

OTHER ERIC REFERENCES:

ERIC SATELLITE CODE

10. VOL.	11. PAGES	12. MO./YR.	13. TOTAL PP.
N.A.	N.A.	June 60	9

B. INDEXING DATA

14. SUBJECT AREA

15. TYPE OF ENDEAVOR

report

16. INDEXING TERMS (6-12)

progress reports P-23
buildings and equipment R-28
materials O-10
teaching aids Y-22
engineering education G-14
professional education P-20
technology Y-27

17. ABSTRACT (MAX. 250 WORDS)

Reports on Project DASFE 2, Design of Auditorium-Studio Facilities for Engineering Education, undertaken by the School of Architecture.

ERIC No.

18. SOURCE OF ABSTRACT

C. FUNDING DATA

19. SUPPORTING ORGANIZATION	20. DIVISION OR DEPT.	21. CONTRACT NO. / PROJECT NO.
	22. TOTAL COST OF PROJECT	
	23. DURATION OR PROJECT	U.S. Department of Health, Education, and Welfare Office of Education

IV-8

TOWARD MORE EFFECTIVE Teaching AT RENSSELAER

IV

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Number 7

June, 1960

U. S. DEPARTMENT OF HEALTH, EDUCATION AND WELFARE
Office of Education

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PROGRESS REPORT
IMPROVED TEACHING MATERIALS, EQUIPMENT, AND FACILITIES

Examination of teaching-learning procedures has led many departments to develop improved teaching materials, to acquire or develop associated equipment, and to plan and develop classroom facilities essential to use of improved techniques of presentation, especially to large groups. The following summaries of representative and inter-related activities at Rensselaer indicate not only progress to date but also directions which such efforts may take in the future.

● FILMS AND OTHER PHOTOGRAPHIC AIDS. Considered as one of several information resources, the instructional film appears to help fulfill a communications requirement in selected academic areas. To date, Project Reward, in co-operation with Rensselaer faculty, has completed the production of ten films that have been especially designed to mediate instruction in the following areas: Chemistry, Civil Engineering, Engineering Drawing, Language and Literature, Mechanical Engineering, Mechanics, and Physics. (See Newsletter Issue No. 6, pp. 1-3.)

Scheduled for production or actually in progress are a third film in Chemistry, with Professor S. E. Wiberley as content authority; four additional films in Engineering Drawing, with Professors H. B. Howe and L. W. Thrasher providing content; two in Physics, with Professor H. F. Meiners as content authority; and a second, low-budget, field-trip type film in co-operation with Professor J. F. Throop of Mechanics. Project Reward staff responsible for the design and cinematography of films now scheduled are Professor W. L. Millard (Engineering Drawing and Mechanics) and Professor C. C. Werberig (Chemistry and Physics).

In still photography, Project Reward has produced during the past 12 months approximately 1,300 slides and 3,000 prints, many of which involved

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location photography in departmental or research laboratories. This represents an over-all increase of about 115 per cent over the previous year's operation. In addition, a great deal of specialized still photography has become necessary in the production of animated films.

● DEMONSTRATION APPARATUS. Especially prominent among the departments that continuously update their lecture-demonstrations and laboratory instruction with new apparatus and materials is the Department of Physics. (See Newsletter Issue No. 4, pp. 5-6, and No. 5, pp. 6-8.) During the nearly-completed, three-year program of revising the content and structure of Rensselaer's introductory physics sequence, more than 20 new laboratory experiments and a much greater number of new lecture-demonstrations have been constructed. In this development, the overhead projector has been used extensively for the projection of large photographic transparencies, of overlays, and of motorized plastic models to magnify small phenomena. Also, many electronic devices have been constructed, such as the projection system used to program images to illustrate gravitation, planetary motion, and celestial mechanics for a series of instructional films. These activities, together with the publication of a new textbook and a new laboratory manual and the development of a large film and slide collection, have been aimed at facilitating the integration and communication of concepts in modern and classical physics. Many aspects of this program will continue to develop through financial grants for individual projects. (For further details, contact Professors Robert Resnick, Harry F. Meiners, or Walter Eppenstein.)

In the Department of Mechanics, Professors R. H. Trathen and L. T. Assini have undertaken a project to develop small-scale demonstration apparatus to help in the exposition of concepts in Statics and Strength of Materials and in Dynamics. Designed for initial use in front of a TV camera, each demonstration will be 3 to 5 minutes in duration, but it is planned that they will eventually be filmed, for integration in lecture presentations whenever desired. Representative of the apparatus planned for development are small models, already completed, representing vibratory phenomena and diagonal stresses in torsion fields. The overhead projector is also being used as a substitute for the customary chalkboard.

Not only in the Departments of Physics and Mechanics is overhead projection becoming an important part of lecture presentations, but also in Language and Literature and in Management Engineering. The visual development of concepts through a sequence of overlays appears to be greatly advantageous in widely diversified areas of instruction.

● CLOSED-CIRCUIT TELEVISION. Closed-circuit television continued to be used in the Strength of Materials Laboratory course during the current semester, with all 265 students taught via this medium. Conclusions resulting from the controlled evaluation study conducted during Spring 1958 (see Newsletter Issue No. 4. pp. 1-2) have been confirmed by experience since that

time. For Strength of Materials Laboratory, this teaching medium is, without doubt, very effective.

The Department of Metallurgical Engineering also continues to use its TV system as a teaching aid for the magnification of microscopic views of metal surfaces and for remote viewing of welding and vacuum melting furnace operations. (See Newsletter Issue No. 4, p. 11.) In addition, the Department of Physics has recently acquired a small TV system for magnifying oscilloscope patterns, microscopic views, and other small-scale phenomena.

● TEACHING MACHINE. For the past year, an electronically programmed training device has been under development, with members of the Department of Electrical Engineering designing and constructing a prototype to meet the educational requirements specified by the Department of Psychology. Through continuous feedback, the device will keep the student informed of the accuracy of his answers; it will also be sufficiently versatile to allow for several variations of a correct answer, and will maintain a record of false attempts in the answering of a question. Thus, the learning requirements upon which the machine is based eliminate the possibility of a student having to undergo a process of "unlearning" caused by the carry-over of false associations.

Design of the machine as a whole, and the construction of the memory and logic device which is the basis of the machine's operation, have been completed by Mr. W. R. Knapp, Jr., as part of his Master's program in Electrical Engineering. When the remaining components are acquired and the prototype completed, Professor G. W. Boguslavsky of the Department of Psychology expects to test a variety of teaching programs, as well as evaluate the machine for possible modifications. Funds are now being invited for the support of the programming and evaluation activities.

● PILOT AUDITORIUM-STUDIO. Physical renovation of Room 101, Troy Building, has been completed to the extent that it has been serviceable for class use during the present semester. (See Newsletter Issue No. 6, pp. 8-9, for background details.) The acoustical conditions, ventilation, controlled lighting, facilities for TV monitor and rear screen motion picture viewing, sliding chalkboards, and versatile sound systems have contributed greatly to the physical resources which the instructor has at his disposal, as well as to the comfort and the ease of concentration which students experience. To date, the room has been used by the Departments of Chemical Engineering, Civil Engineering, Mechanics, and Psychology.

At the lecture table, the instructor has remote control of the main, cove, chalkboard, and spot lighting of the room; of a motion picture projector behind the large rear projection screen; of all inputs to the audio system; and of audio and video signals between the TV studio below, the pilot auditorium, and any additional rooms that may be added to the electronic system. The large rear screen is 5 ft. by 16 ft., and besides being used now for motion picture projection, will eventually also be used for slides and TV, with sufficient screen area available for all types of projection to be utilized concurrently, if desired.

A smaller, 3 ft. by 4 ft., rear projection screen also allows for the special projection of problems and permits the instructor to sketch the answer, when appropriate, on the front surface. Two slide projectors and a TV projection unit are the principal items presently needed to give the room maximum efficiency. Funds are being invited for these additional resources.

Renovation of the room has been under the direction of Professor R. H. Trathen, Department of Mechanics.

● PROJECT DASFEE. See separate progress report, later in this issue, on an investigation currently being conducted by the School of Architecture, concerning design studies of auditorium-studio facilities for the effective teaching of concepts in engineering education.

* * * * * * *

It is to be emphasized that the above summaries are not inclusive, but only representative of the many current activities concerned with the improvement of teaching materials, equipment, and facilities. These activities - plus others dealing with such important matters as class size, advanced placement, and curricular revision - form an over-all institutional research program whose ultimate objective is to provide better teaching to more students at lower unit cost.

AN AID IN TEACHING COMPUTER PROGRAMMING

For use in teaching computer programming, Professor J. W. Hollingsworth has developed an automatic grader which is, in itself, a computer program. It guides the computer through a process of reading student-written programs, supplying appropriate comment if a program is correct, or, if incorrect, detecting errors and supplying extra data necessary for the student to locate and correct his mistakes.

The automatic grader has been developed in connection with a one-semester, formal programming course in which high competence in computer programming is the objective. Formerly, each student in this course required 15 to 20 minutes of computer time per week, under the guidance of a laboratory instructor, for trying out a program he had written, or, roughly, four or five hours per semester. With the automatic grader, however, the same grading task requires only about one hour and a half of computer time. Therefore, in a typical programming class of twenty students, the ratio of computer time required by the old and new methods is in the order of three to one. The saving in instructor time is great, and ten to twelve times more efficient use is made of the computer (an IBM 650).

When this technique is extended to a proposed introductory course in programming for all sophomores, the automatic grader, with only a few minutes'

computer time allowed for each student's programs, will make possible the effective teaching of programming essentials as an element in a course having approximately 800 students enrolled. The grader will thus help to implement a current educational objective that all Rensselaer undergraduates be acquainted with the "how" of solving problems on computers and the potential uses of computers (see Issue No. 5 of this Newsletter, pp. 1-4).

The development of the automatic grader has been under way for the last year. Its present high rate of efficiency is expected to become even greater in the specific applications that have been investigated. Other applications, such as the grading of homework in other selected courses, remain to be explored.

For further details, contact Professor J. W. Hollingsworth, Computer Laboratory.

GROUP PROJECTS - AERONAUTICAL ENGINEERING

During the current semester, several student-manned projects involving engineering analysis and design have been initiated within the Aeronautical Engineering instructional program. The project system of instruction - based heavily upon voluntary student participation, independent study, and team-research - seeks to (1) improve the effectiveness of curricular areas dealing with analysis and design, (2) provide for all participants an experience realistically oriented toward the operational character of the professional jobs they will undertake upon graduation, (3) help freshmen who have designated Aeronautical Engineering as their field of concentration to identify themselves with the department while taking only subjects common to all first-year engineering and science students, (4) give the participants a pragmatic and continuing demonstration of the value and the purpose of the basic and applied sciences, and (5) provide a testing ground for new ideas and a mechanism for the exploration of new research problems before they reach proposal form. At present, students have under way a ground effect machine project, and four others dealing with pulsed-plasma propulsion, a plasma accelerator, a ramjet, and a high-speed subway. Participants for each project include seniors, juniors, sophomores, and freshmen.

Each project is under the direction of one or two seniors. As "project engineers" these seniors are responsible for the correlation of the information which is provided to them by their "subordinates" and of the advice which they receive from their consultants (the faculty). They make all important choices and decisions in connection with design, construction, and testing of the object of their team's work.

The seniors are assisted by juniors in those areas of analysis in which the juniors have an adequate background in the engineering sciences. The junior thus applies the knowledge which he has just acquired in his theory courses and in the laboratory, and the application is not an abstract problem but rather

something of real, practical, immediate importance to the student himself.

Sophomores and freshmen assist the juniors in various capacities - as draftsmen, computers, secretaries, and library or shop workers. They are made to feel that they are part of the team and that their role is important. They grow with the project.

At the end of each academic year, it is planned that the juniors, sophomores, and freshmen whose performance has been satisfactory will be promoted to the next higher rank. Students who do not perform satisfactorily will be relieved from their projects and required to take a formal design course in the second semester of their senior year. Those who participate satisfactorily throughout the four undergraduate years will thereby earn credit equivalent to the formal course.

Initial student reaction to the project system has been enthusiastic. As the system evolves, it is hoped that each student will achieve a high level of vital and significant experience in creative design and in engineering analysis.

For further details, contact Professor J. V. Foa, Head of the Department of Aeronautical Engineering.

PROGRESS REPORT - PROJECT DASFEE

As an approach to more effective utilization of new and rapidly developing instructional aids and media, the School of Architecture at Rensselaer has undertaken its current building-type study, Project DASFEE. DASFEE, Design of Auditorium-Studio Facilities for Engineering Education, is being supported by a grant from Educational Facilities Laboratories, Inc., and is directed specifically at the architectural considerations of the spaces in which all or part of the instruction utilizes techniques based on open- and closed-circuit television, slides, films, other projected materials, models, and demonstration apparatus. The educational feasibility of these techniques has been explored through a number of sponsored studies, but DASFEE provides the first opportunity for a school of architecture to consider the implications which these techniques have upon the spaces and their design features.

The initial part of the investigation has been devoted largely to the development of design programs, which are definitions of the spaces. Later, these programs will be translated into prototype studies. As outlines of the type, function, size, equipment needs, and special design features of the spaces, the programs are the verbal blueprints of the studies. Obviously, they must be based upon and follow logically from the educational philosophies and methods which incorporate the new aids and media. To gain an understanding of these methods, the Project staff has reviewed research and study reports, conference reports, articles, books, dissertations, and other sources. Members of the staff have also visited a number of institutions that are utilizing television and other new media, not only to see the facilities involved and the way they

function, but also to talk with persons responsible for their development and use. To obtain a broader view of the developments specifically within engineering education, a questionnaire survey of schools of engineering was conducted. The high response, over 90 per cent, gives a good indication of the extent to which such media are used in engineering education throughout the country. Schools indicating facilities pertinent to the Project are being further contacted and visited.

Finally, to establish an architect-client relationship across a conference table, a number of well-known educators with backgrounds in the use of the new aids and media, and several architects experienced in the programming and designing of educational facilities, met at Rensselaer for two days early in April. The sessions proved valuable as an opportunity for the exchange of experiences and viewpoints and in further formulating of the design programs.

Soon work will begin on prototype studies of the facilities outlined in the design programs. These studies will not involve design of actual buildings, but will establish design criteria and solutions that can, by adaptation to fit a specific program, be used as a guide for building or remodeling facilities. As the prototype studies evolve, consultants in such areas as equipment, fixtures, acoustics, lighting, and structures will be brought in to aid in the solution of problems in these particular design areas. In the fall, a group of educators, architects, and design specialists who have been involved with the Project will return to the campus for a review and critique session. The final report on the investigation will be submitted to the sponsoring agency early in 1961.

USE OF THE SEMINAR IN MASTER'S DEGREE PROGRAMS AT HARTFORD GRADUATE DIVISION

Although the thesis requirement is normally waived in master's degree programs at the Hartford Graduate Division, all students are required to participate in a seminar activity to the extent of at least one credit hour in fulfillment of the requirements of the master's degree. Since these students are professionally employed in fields which usually include experimental or laboratory work, it appears that there may be greater educational value in the substitution of other types of activities in their master's program in lieu of a thesis, which normally would provide a large measure of experimentation or laboratory experience. It is felt, however, that the search and critical evaluation of the existing literature in a thesis subject area is of great value to the master's student and is often not adequately provided for in his professional employment. Therefore, the Hartford faculty believes the seminar to be especially valuable as a means of providing for this type of activity.

Two general approaches are open to the student for meeting this seminar requirement. One is a "regular" class, conducted on a seminar basis. This is particularly well adapted to advanced classes in some subject areas where the class size is rather small. An interesting development along this line,

but in which the class is not necessarily small, is one in which three or four seminar students may be enrolled along with a regular class. The course as a whole benefits by this note of variety which enters and by the opportunity to extend the basic material of the body of the course into the advanced area of the seminar. Obviously, part of the time of preparation of classroom lectures is now shifted to the student who plays the dual role of student and teaching assistant, releasing more time for the professor's critique. The paper which the seminar student is required to develop may be 25 to 50 pages in length, and indeed may not be an original piece of work, but it is an expressive and therefore a creative one, requiring a careful literature search and paving the way to a true research effort.

The second approach involves the formal seminar. This has been done under the special topics course title and usually is aimed at some advanced field. For example, one recent seminar for electrical engineering students dealt with topics selected from the field of servomechanisms. The seminar was open to students of electrical engineering and to those students with advanced standing in the master's program who had already acquired electrical engineering backgrounds through previous courses in servomechanisms.

The formal seminar is conducted as follows: Preferably, students select, or they may be assigned, topics in a subject matter area with which they are to become familiar in detail throughout the course of the seminar. It is expected that approximately 100-150 hours of study will be devoted to this pursuit outside of the class time.

Class meetings are held in the first part of the term to select topics and to indicate procedure. Once each student is under way on his topic, weekly class sessions are held, if needed, for discussion of topics with the instructors. About halfway through the term, written and oral progress reports are given by each student. A final presentation, both written and oral, is made by each student in a full class period at the close of the term. This session is open to all faculty and students. No final examinations are required.

The level of effort and scholarship required is commensurate with that normally expected of a master's thesis requirement. The student is expected, through an exhaustive literature search, to indicate a thorough understanding of his chosen topic. It is definitely not intended that the student review only one or two papers in a given subject, but rather that he make a broad research effort for each topic chosen.

For the last three semesters, the metallurgy majors have participated in a seminar which also serves as a partial replacement of the thesis requirement, but with particular emphasis on the type of subject matter to be investigated. Taken as a special topic, this seminar requires that the student select, with the approval of the metallurgy staff, a controversial subject for his comprehensive term paper. The conflicting literature must be reviewed and evaluated and a point of view taken and defended.

Although the seminars described above are not to be considered as thesis substitutes, they are one way of introducing some of the values of the thesis

into a master's program that has been designed for students who are concurrently acquiring professional experience as engineers and scientists.

For further details, contact Dr. Warren C. Stoker, Dean of Rensselaer's Hartford Graduate Division at East Windsor Hill, Connecticut.

RECENT PUBLICATIONS RESULTING FROM EXPERIMENTS IN EDUCATION AT RENSSELAER

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Marcley, Robert G., "Bragg Diffraction Apparatus," Apparatus Drawings Project, Report Number 6, Am. J. Phys., 28, 415-417 (1960). (This apparatus was developed under the direction of Harry F. Meiners of Rensselaer's Department of Physics.)

Marcley, Robert G., "Magnetic Field of a Circular Coil," Apparatus Drawings Project, Report Number 2, Am. J. Phys., 28, 147-150 (1960). (This apparatus was developed by George F. Robinson and Walter Eppenstein of Rensselaer's Department of Physics.)

Meiners, Harry F., "A Demonstration of Bragg Diffraction from a Flexible Macroscopic Lattice," (Abstract) Am. J. Phys., 27, 680 (1959).

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Moore, Kenneth H., "Advanced Placement Program in Physics," Am. J. Phys., 28, 279-284 (1960).

Resnick, Robert, and Halliday, David, Physics for Students of Science and Engineering. New York: John Wiley and Sons, Inc., 1960.

Trathen, R. H., "Two Years of Experimental Work on Various Teaching Methods and Class Sizes," J. Eng. Educ., 50, 380-387 (1960).

(For publications previously listed, see Newsletter Issue No. 5, p. 12, and No. 6, p. 12.)

Toward More Effective Teaching at Rensselaer, a faculty newsletter published occasionally by Project Reward, is a medium for the exchange of information concerning experiments in education at R.P.I. Faculty members are invited to submit items for the newsletter to Project Reward, McCarthy Hall, Extension 388.